#6 Translation

Declaration

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【Object】 Specification 1

【Object】 Drawing 1

【Object】 Abstract 1

【Name of Document】 SPECIFICATION

【Title of the Invention】 GENERATOR WITH DIVERSE POWER-GENERATION CHARACTERISTICS

【What is Claimed is】

【Claim 1】 A generator with diverse power-generation characteristics, comprising a rotor supported for rotation in a stator frame and having mounted with permanent magnets of multiple poles, and a stator arranged around the rotor and fixed to the stator frame, wherein the stator is composed of a stator core having teeth arranged spaced circumferentially to form sequential slots and confronting an outer periphery of the rotor to define an air gap between them, and more than one windings shunt-wound or concentrated-wound spanning across the slots, the windings being each grouped into three winding sets that are divided circumferentially with a slot span on the stator core, the windings belonging to each winding set being wound displaced in slot circumferentially 120 electrical degrees apart to form a three-phase system of windings, and wherein terminals are distributed uniformly over an inside circumference of the stator such that the windings in a 2nd winding set are arranged in the stator slots so as to overlap with a 1st winding set in waveform of emf, while a 3rd

winding set overlaps with the 1st set and the 2nd set in waveform of emf, and a controller unit changes over connections of the terminals every winding sets, thus giving any electric power varied in voltage.

【Claim 2】 A generator with diverse power-generator characteristics constructed as defined in claim 1, wherein the winding are grouped into any of three and four winding sets, which are laid in the slots displaced circumferentially of the inside cylinder.

【Claim 3】 A generator with diverse power-generator characteristics constructed as defined in claim 2, wherein a-c power produced in the windings in the winding sets is rectified at a rectifier circuit, and the resultant rectified power is adjusted by a chopper circuit to a preselected voltage.

【Claim 4】 A generator with diverse power-generator characteristics constructed as defined in claim 1, wherein the winding sets are each constructed in mutually independent electric power source where the produced power may be used either remained a-c form or converted to d-c form.

【Claim 5】 A generator with diverse power-generator characteristics constructed as defined in claim 1, wherein terminals of the windings in the

winding sets are selectively connected in series and/or parallel by the controller unit, whereby a low tension induced in the windings of the winding sets is consumed in automotive electric systems, whereas a high tension is consumed to energize the heaters incorporated in diesel particulate filters and so on equipped on automotive vehicles and/or to drive the auxiliaries mounted on the vehicles.

【Claim 6】 A generator with diverse power-generator characteristics constructed as defined in claim 1, wherein the windings for high tension are divided into three winding sets and shunt-wound, the terminals of the windings are selectively connected in series and/or parallel by the controller unit, and the windings for low tension are concentrated-wound to produce the low tension needed to operate the automotive electric system of 24V and so on.

【Claim 7】 A generator with diverse power-generator characteristics constructed as defined in claim 4, wherein the controller unit connects all the concentrated-wound winding sets in series to ensure the maximum high tension, connects any of the concentrated-wound windings in series to ensure any tension less than the maximum high tension and further connects all the concentrated-wound windings in parallel to produce

the minimum tension.

【Claim 8 】 A generator with diverse power-generator characteristics constructed as defined in claim 1, wherein the controller unit controls an inverter to convert direct to alternating form to drive a motor by the electric power produced in the windings in the winding sets.

【Claim 9 】 A generator with diverse power-generator characteristics constructed as defined in claim 1, wherein the winding sets are such arranged that working windings come in symmetry on generation.

【Claim 10】 A generator with diverse power-generator characteristics constructed as defined in claim 1, wherein the windings in the winding sets are connected to form either a star-connection or a delta-connection to provide a three-phase system of windings, and ends of the star-connected or delta-connected windings are connected in series to the terminals through a relay.

【Detailed Explanation of the Invention 】

【0001】

【Technical Field to which the Invention Pertains 】

The present invention relates to a generator having diverse power-generation characteristics, comprising a rotor of permanent magnets mounted on a

rotator shaft supported in a stator frame for rotation, and a stator arranged around the rotor.

【0002】

【Prior Art】

Modern advanced permanent magnets of high performance have become much employed on a rotor of a generator/motor. Moreover, as the generator/motor having the rotor structure of permanent magnets is high in efficiency of electromechanical energy conversion and simple in construction, its use has recently grown in industrial machines and instruments of various kinds. Then, much research and development have continued to make the generator/motor compact or slim in construction, with even high performance and high power output, and correspondingly necessitated a diversity of parts and components.

【0003】

In order to increase a torque at low speed in the conventional motors, it is effective to increase the strength of the magnetic field of the stator around the rotor, thereby raising the torque. With the motors, thus, increasing well the torque causes the increase of electromotive force at a low speed, contributing to the provision of commercially viable power source for machines. Among the motors employing the permanent-

magnet rotor is, for example a permanent-magnet rotating machine disclosed in Japanese Patent Laid-Open No. 272850/1987. The prior permanent-magnet rotating machine disclosed in the above gazette has a rotor in which permanent magnets are arranged and containers are provided to contain therein magnetic material that is allowed to flow radially owing to the revolution of the rotor to thereby form magnetic pole pieces.

【0004】

Moreover, another prior art of an a-c generator/motor developing a high-power output is disclosed in Japanese Patent Laid-Open No. 236260/1995, in which a magnetic flux density is controlled in proportion to the rpm of the rotor to adjust properly an amount of the generated amperes or voltages. A control ring is arranged between the rotor and the stator for rotation relatively of them and further a permeable member is provided in such a manner as to come in and out contact with the control ring.

【0005】

【Problems that the Invention is to Solve】

In the meantime, as most automotive electric equipments are designed to require either 12V or 24V, the automotive alternators need to have the generation characteristic capable of feeding the electric power

matching to the voltage recited just above. Nevertheless, the d-c power of either 12V or 24V is too low to operate the machinery and instruments mounted on an automobile, in which much power is required for their operation. Moreover, a major problem exists in which too thick in cross section of conductor is necessitated for the winding. To cope with this, the alternator is needed producing not only the electric power of low voltage matching to the voltage required for the automotive electric equipments but also another electric power which is enough to reduce the transmission loss in the wiring and render the conductor such as winding thin in cross section, thereby making it possible to drive the auxiliaries constructed compact or slim.

【0006】

With the permanent-magnet generator/motor, the permanent magnet is fixed in magnetic flux density. Thus, the increase of the torque at a low speed needs to either make the permanent magnet large in size or increase the current and also increase the number of loops or turns in the winding to intensify the strength of the magnetic field at the stator side. To realize much torque, it is necessary to make the conductor wound on the stator core heavy in cross section thereby

increasing the magnetic force of the stator. Nevertheless, too heavy in cross section of the winding conductor laid in a slot of the stator core makes it tough to lead the conductor through the slot between any adjacent teeth in the stator core and embed the windings in the slot of the stator core.

【0007】

【Means to Solve the Problems 】

It is a primary object of the present invention to overcome the problems stated earlier and to provide a generator having diverse power-generation characteristics, in which more than one windings either shunt-wound or concentrated-wound in slots between any adjacent teeth are connected in parallel and/or in series, with changed in combination to ensure powers different in voltage from one another, each of which may be applied across any loads requiring different voltages, for example automotive electric equipments of 12V ～ 24V and auxiliaries such as heaters, diesel particulate filters and so on of 30V～100V.

【0008】

The present invention relates to a generator with diverse power-generation characteristics, comprising a rotor supported for rotation in a stator frame and having mounted with permanent magnets of multiple

poles, and a stator arranged around the rotor and fixed to the stator frame, wherein the stator is composed of a stator core having teeth arranged spaced circumferentially to form sequential slots and confronting an outer periphery of the rotor to define an air gap between them, and more than one windings shunt-wound or concentrated-wound spanning across the slots, the windings being each grouped into three winding sets that are divided circumferentially with a slot span on the stator core, the windings belonging to each winding set being wound displaced in slot circumferentially 120 electrical degrees apart to form a three-phase system of windings, and wherein terminals are distributed uniformly over an inside circumference of the stator such that the windings in a 2nd winding set are arranged in the stator slots so as to overlap with a 1st winding set in waveform of emf, while a 3rd winding set overlaps with the 1st set and the 2nd set in waveform of emf, and a controller unit changes over connections of the terminals every winding sets, thus giving any electric power varied in voltage.

【0009】

In an aspect of the present invention there is disclosed a generator in which the winding are grouped into any of three and four winding sets, which are laid

in the slots displaced circumferentially of the inside cylinder.

【0010】

In another aspect of the present invention there is disclosed a generator in which an a-c power produced in the windings in the winding sets is rectified at a rectifier circuit, and the resultant rectified power is adjusted by a chopper circuit to a preselected voltage.

【0011】

In another aspect of the present invention there is disclosed a generator in which the winding sets are each constructed in mutually independent electric power source where the produced power may be used either remained a-c form or converted to d-c form.

【0012】

In another aspect of the present invention there is disclosed a generator in which terminals of the windings in the winding sets are selectively connected in series and/or parallel by the controller unit, whereby a low tension induced in the windings of the winding sets is consumed in automotive electric systems, whereas a high tension is consumed to energize the heaters incorporated in diesel particulate filters and so on equipped on automotive vehicles and/or to drive the auxiliaries mounted on the vehicles.

【0013】

In another aspect of the present invention there is disclosed a generator in which the windings for high tension are divided into three winding sets and shunt-wound, the terminals of the windings are selectively connected in series and/or in parallel by the controller unit, and the windings for low tension are concentrated-wound to produce the low tension that is needed to operate the automotive electric system of 24V and so on.

【0014】

In a further aspect of the present invention there is disclosed a generator in which the controller unit connects all the concentrated-wound winding sets in series to ensure the maximum high tension, connects any of the concentrated-wound windings in series to ensure any tension less than the maximum high tension and further connects all the concentrated-wound windings in parallel to produce the minimum tension.

【0015】

In another aspect of the present invention there is disclosed a generator in which the controller unit controls an inverter to convert direct to alternating form to drive a motor by the electric power produced in the windings in the winding sets.

【0016】

In another aspect of the present invention there is disclosed a generator in which the winding sets are such arranged that working windings come in symmetry on generation.

【0017】

In another aspect of the present invention there is disclosed a generator in which the windings in the winding sets are connected to form either a star-connection or a delta-connection to provide a three-phase system of windings, and ends of the star-connected or delta-connected windings are connected in series to the terminals through a relay.

【0018】

A generator with diverse power-generation characteristics constructed as described above, for example, most automotive electric systems need the power of about 0.5KW～1KW at the voltages of 12V～28V, whereas the auxiliaries mounted on the automobile need the power of about 2KW～3KW. If someone could get the voltages of 12V ～28V to cover the power of about 3KW for the auxiliaries, the current value would become too large, thus causing power loss with much heating. As opposed to the condition stated earlier, the auxiliaries or auxiliary machinery is allowed to

operate on the high tension of about 100V ～200V, thus involved in no problem of power loss in the wiring. Accordingly, the winding adapted to produce the high tension supplied to the auxiliaries, for example is allowed to make slender or thin the conductor in cross section, thereby contributing to rendering the generator slim in construction and light in weight. Besides, when any relay is used, the voltage may be more increased with the result of less current, thus protecting any contact against possible fusion.

【0019】

【Mode for Carrying Out the Invention】

A generator with diverse power-generation characteristics in accordance with the present invention will be hereinafter described with reference to the accompanying drawings. FIG. 1 is an axial sectional view showing a preferred embodiment of a generator with diverse power-generation characteristics in accordance with the present invention, FIG. 2 is a cross-sectioned view taken along the plane A-A of FIG. 1 to illustrate concentrated-field windings or shunt-field windings on a stator core, FIG. 3 is a plan view showing a stator core, FIG. 4 is a schematic illustration explanatory of windings mounted on the stator core, FIG. 5 is a wiring diagram explaining

circuit connections of the windings in the generator of FIG. 1, FIG. 6 is a graphic representation showing relations between rpm and output voltage occurring in the circuit connections in FIG. 4, FIG. 7 is a graphic representation showing three-phase currents created in the generator of the present invention, FIG. 8 is an illustration explanatory of star-connected winding sets and FIG. 9 is an illustration explanatory of delta-connected winding sets.

【0020】

The generator according to the present invention is suitable for use, for example in the generators combined with an automotive engine, generators incorporated in an engine for cogeneration system, generators attached to an output shaft of an engine for a hybrid vehicle, generators combined with a turbocharger to reclaim heat energy from exhaust gases, or generators mounted to energy recovery means.

【0021】

The generator of the present invention, as shown in FIG. 1, is comprised of a pair of frame halves 1A and 1B, a rotor shaft 2 supported for rotation by means of axially opposite ball bearings 23 through washers 26, a rotor 5 of permanent-magnet pieces 3 arranged around and fixed to the rotor shaft 2, and a stator 6

arranged around the outer periphery of the rotor 5 to define an air gap 22 between them and fixed to the frame halves 1A and 1B. Thus, the rotor 5 is accommodated in a cylindrical hollow 28 for rotation with keeping the air gap 22 of a preselected radial clearance. The rotor 5 is clamped between axially opposite backing plate 25 and retainer plate 27, which are abutted against axially opposing ends of the rotor 5, each to each end, and kept on the rotor shaft 2 against rotation by tightening a nut 29 on a threaded end 21 of the rotor shaft 2. A generator pulley 16 fixed to any one end of rotor shaft 2 with a nut 29 is connected through a belt to a rotating shaft, turbine shaft, driving shafts for compressor and so on, which are connected to the engine through any transmission system.

【0022】

As seen from FIGS. 2 and 3, the stator 6 comprises a stator core 7 constructed of an outside cylindrical magnetic path 8 with stator teeth 10 arranged spaced circumferentially apart from each other to separate two adjacent stator slots 9, which open onto or near the air gap 22 kept between the outer periphery of the rotor 5 and the tooth tips 28, and windings 13A, 13B and 13C wound on stator teeth 10 with spanning some

stator slots 9 each of which is between any two adjacent teeth 10 of the stator core 7. The windings 13A, 13B and 13C are each grouped into three winding sets 30A, 30B, 30C and 30D that are divided circumferentially regarding the stator slots 9 of the stator core 7. The windings 13A, 13B and 13C belonging to any one winding set 30A, 30B, 30C or 30D are each shunt-wound or concentrated-wound and shifted from each other in the stator slots 9 to form a three-phase system of windings. With the generator stated earlier, a controller unit 30 switches over connections among terminals 14 of the windings 13A, 13B and 13C belonging to any one winding set 30A, 30B, 30C or 30D to produce any electric powers varied in voltage. As will be seen from FIG. 5, the winding set 30A is adapted to produce a current of low voltage directed to automotive electric equipments of 12V～24V, so that the windings 13A, 13B and 13C in the winding set 30A are concentrated-wound. Other winding sets 30B, 30C and 30D are each split into three parts and shunt-wound for producing electric power of high voltage. The operation of the controller unit 30 connects the terminals 14 of the windings 13A, 13B and 13C in series and/or in parallel.

【0023】

The winding sets 30A, 30B, 30C and 30D, as shown in FIG. 4, are grouped into three or four sets: 1st set (R, S, T), 2nd set (U, V, W) and 3rd set (X, Y, Z) laid in the stator slots of the stator core, which are displaced circumferentially from each other. In FIG. 4, the windings R, U and X are represented by a solid line while the windings S, V and Y are shown by a dotted line and the windings T, W and Z are represented by a dot-and-dash line. The stator slots 9 in FIG. 4 are numbered in one consecutive series from No. 1 to No. 36 for convenience of explanation while the three windings 13A, 13B and 13C in any winding set 30A, 30B, 30C or 30D are spaced 120 electrical degrees apart on the stator teeth 10 to provide the three-phase system of windings helping ensure a preselected voltage. Moreover, an alternating-current induced by the three windings 13A, 13B and 13C in the winding set 30A, as shown in FIG. 5, is rectified or changed to d-c, which is in turn adjusted through a chopper circuit in a voltage regulator 42 to a voltage needed for the automotive electric systems. Other winding sets 30B, 30C and 30D are arranged such that working windings come in symmetry on generation.

【0024】

As shown in FIGS. 2 to 5, the windings 13A, 13B

and 13C are grouped into winding sets 30B, 30C and 30D circumferentially regarding the stator slots 9 on the stator core 7. The three winding sets 30B, 30C and 30D are wound in the stator slots 9 spaced circumferentially 120 electrical degrees apart to form the three-phase system of windings. Thus, the terminals 14 are distributed uniformly over the inside circumference of the stator such that the windings in the 2nd set (U, V, W) are arranged in the stator slots 9 so as to overlap with the 1st set (R, S, T) in waveform of emf, while the 3rd set (X, Y, Z) may overlap with the 1st set (R, S, T) and the 2nd set (U, V, W) in waveform of emf. On operation of the generator stated earlier, any terminals 14 of the winding sets 30B, 30C and 30D are controlled to make connections by the controller unit 30, thus giving any electric power varied in voltage. In FIG. 7, a dotted curve PC denotes a low tension at electrical degrees where the windings 13A, 13B and 13C are connected in parallel or remain alone, while a dot-and-dash curve C2 is a medium tension at other electrical degrees where any two windings out of the windings 13A, 13B and 13C are connected in series. A solid curve C3 corresponds to a high tension at further other electrical degrees when all the three windings 13A, 13B and 13C are

connected in parallel.

【0025】

As shown in FIG. 5, the terminals 14 of the windings 13A, 13B and 13C in the winding sets 30B, 30C and 30D are selectively connected in series and/or parallel by the controller unit 30. As a result, the high tension induced in the windings 13A, 13B and 13C of the winding sets 30B, 30C and 30D is intended to be consumed to energize the heaters incorporated in diesel particulate filters and so on equipped on automotive vehicles and/or to drive the auxiliaries mounted on the vehicles. The winding sets 30B, 30C and 30D are arranged such that working windings come in symmetry on generation. Moreover, the windings belonging to each winding set makes either star-connection as shown in FIG. 8 or delta-connection as shown in FIG. 9 to provide the three-phase currents. Ends of the star-connected or delta-connected windings are connected in series to the terminals 14 through a relay.

【0026】

The controller unit 30 operates to connect the three winding sets in series with each other to ensure the maximum high tension, whereas the voltages lower than the maximum high tension may be produced by either the series connection of any two winding sets or the

parallel connection of the three winding sets. Moreover, the controller unit 30 controls an inverter to convert direct to alternating form to drive a motor by the electric power induced at the windings in the winding sets.

【0027】

The stator core 7 constituting the stator 6 is formed of a toothed member 7 where the cylindrical magnetic path 8 is integral with the teeth 10. The cylindrical magnetic path 8 of the toothed member 7 is made of soft material superior in permeable property. In the stator 6, the windings 13A, 13B and 13C laid in the slots 9 between the adjacent teeth 10 of the toothed member 7 are held firmly in the slots 9 with resinous material 11 that has been poured then, followed by solidification. Moreover, the windings 13A, 13B and 13C are led through slot openings 20 between the adjacent teeth 10 of the toothed member 7 and then wound up with spanning the slots 9.

【0028】

In this generator with diverse power-generation characteristics, it will be understood from FIGS. 2 and 4 that the three-phase currents U, V, W (in FIG. 4. other reference characters R, S, T and X, Y, Z are given for convenience of understanding) are induced in

each winding set including the winding 13A (current U is marked with ○), the winding 13B (current V is with △) and the winding 13C (current W is with ×), which are concentrated-wound or shunt-wound across the slots 9 between two adjacent teeth 10 with a preselected slot span, although but four 3-phase power supply lines of winding sets, the stator 6 is divided, are shown as the illustrative example in FIG. 5.

【0029】

The stator core 7 contains the windings 13A, 13B and 13C that are concentrated-wound or shunt-wound on the stator core so as to produce the three phase currents U, V and W spaced 120 electrical degrees apart as shown in FIG. 7. In FIG. 4 in which there is shown in development an example of windings spaced 120 electrical degrees apart on the stator, the 1st winding set G1 for the three phase currents R, S and T, 2nd winding set G2 for the three phase currents U, V and W, and 3rd winding set G3 for the three phase currents X, Y and Z are wound on the teeth 10 with a preselected slot span, respectively. The stator 6 is chiefly comprised of the toothed stator core 7 of the cylindrical magnetic path 8 with the teeth 10 arranged spaced circumferentially on the magnetic path 8, the windings 13A, 13B and 13C wound across the slots 9

between any two adjacent teeth 10 with a preselected slot span, and non-magnetic resinous material 11 poured then, followed by solidified to solidly keep the windings 13A, 13B and 13C in the associated slots. Besides, the resinous material 11 is made of any heat-stable material hard to be fused owing to heat emanated from the windings 13A, 13B and 13C.

【0030】

In this generator with diverse power-generation characteristics, a rotor 5 comprises, for example the rotor shaft 2, a magnetically permeable member 12 of laminated silicon steel sheets arranged on the rotor shaft 2, a permanent-magnet member 3 composed of arced permanent-magnet pieces 15 arranged spaced from each other around the permeable member 12 in the form of cylindrical configuration and resinous adhesives bonding together any adjacent permanent-magnet pieces 15, and a reinforcing member 4 of non-magnetic heat-resisting alloy surrounding around the permanent-magnet member 3, the reinforcing member 4 being coated at the inside surface thereof with adhesives. As an alternative, the reinforcing member 4 may be made of a reinforcing tube wound with multi-layered sheets of austenite structure lest the induced current occurs in reinforcing tube. Besides, the resinous adhesives are

made of any heat-stable material hard to be fused owing to heat emanated from the windings 13A, 13B and 13C.

【0031】

In this generator with diverse power-generation characteristics, the windings 13A, 13B and 13C belonging to any of the winding sets 30A, 30B, 30C and 30D are each shunt-wound or concentrated-wound around a field pole corresponding to any pole of the rotor 5. With the generator of the present invention, the series connections 36, 37 and 38 are shunted into parallel connections as the rpm of the rotor 5 increases, thus regulating the generated voltage. At the series connections 36, 37 and 38, either all the four windings or any three windings are connected in series with one another. Switches 33, 34, 35, 36, 37 and 38 are provided in lines, each to each line, where rectifiers 32 are connected to the windings 13A, 13B and 13C as shown in FIG. 5.

【0032】

With the generator constructed as stated earlier, the ON-OFF operation of the switches 33, 34, 35, 36, 37 and 38 serves regulating the generated voltage, for example as seen from TABLE 1 and FIG. 5. Moreover, only the winding set 30A contributes to the electric power for the load 43 as shown in FIG. 5. The electric

power produced in the winding set 30A flows through a bridge circuit 39, a voltage stabilizing coil 40 and a resistor 41 to the voltage regulator 42 with the chopper circuit, where the electric power is controlled to be consumed in the load 43 that is grounded at 44 in FIG. 5.

【TABLE 1 】

Switch #	33	34	35	36	37	38
Winding connections for high tension	33A ON	ON	35A ON	ON	OFF	OFF
Winding connections for medium tension	33A ON	ON	35B ON	OFF	OFF	OFF
Winding connections for low tension	33B ON	ON	35B ON	ON	ON	ON

【0033】

When the controller unit 30 issues an instruction, for example to control the circuit in FIG. 5 in accordance with the ON-OFF operation represented in TABLE 1, the winding sets 30A, 30B, 30C and 30D are controlled to make series connection and/or parallel connection, thus realizing any tension of high, medium and low tensions. The high tension will be provided at the event where all the winding sets 30A, 30B, 30C and 30D are connected in series, the medium tension is at the event where any two out of the winding sets 30A, 30B, 30C and 30D are connected in series, and the low

tension is at the event the winding sets 30B, 30C and 30D are connected in parallel. The resultant output voltage V varies, for example as shown in FIG. 6, for each of the high, medium and low tensions. Thus, the winding sets 30A, 30B, 30C and 30D are each constructed in mutually independent electric power source where the induced power may be used either remained a-c form or converted to d-c form. For instance as tabulated in TABLE 1, the high tension is given when the controller unit 30 turns ON the switches 33A, 34, 35A and 36, while turns OFF the switches 37 and 38, thus making the series connection of all the winding sets 30A, 30B, 30C and 30D. The medium tension is obtained when the controller unit 30 turns ON the switches 33A, 34 and 35B, while turns OFF the switches 36, 37 and 38, thus making only the winding sets 30B and 30C connect in series and the winding set 30D null. The low tension is realized when the controller unit 30 turns ON the switches 33B, 34, 35B, 36, 37 and 38, thus making the winding sets 30B, 30C and 30D connect in parallel.

【0034】

【Effects of the Invention】

With the generator according to the present invention constructed as described above, simply connecting in series and/or in parallel the terminals

of the windings in the winding sets is sufficient to produce any of high, medium and low tensions. That is to say, the controller unit connects all the three winding sets in series to ensure the maximum high tension, and connects any two of the windings in series or connects all the windings in parallel as the desired tension reduces to any tension below the maximum high tension. The high tension given by the series connections of the windings in the winding sets is consumed, for example to energize the heaters incorporated in diesel particulate filters and so on equipped on automotive vehicles and/or to drive the auxiliaries mounted on the vehicles. The low tension produced by the parallel connections of windings in the winding sets is uses for the automotive electric systems.

【0035】

With the stator employed in the generator of the present invention, the stator windings, as being allowed to be led through radially outward slot openings of the slots between the adjacent teeth of the toothed member, may be shunt-wound or concentrated-wound on the stator core with ease, thus helping ensure the stator rich in reliability. Especially, the windings in the winding sets shunt-wound or

concentrated-wound on the stator core are distributed circumferentially in slot every phase and every pole in a manner the magnetic figures are displaced stepwise and the winding curves verge on the sinusoidal form. This makes it possible to make the windings in the slots with efficiency and ease. With the generator constructed according to the present invention, any one power developed in the low-power windings serves as the power necessary for energizing the automotive electric systems while another power produced in the high-power winding is used for the actuation of the auxiliaries such as the heater of the diesel particulate filter, air-conditioner and the power-take-off or the like. The winding connections for high power to generate the high tension may reduce the current value, which is needed of gaining the desired power, thus rendering the conductor small in cross section. This makes it possible to provide the generator compact or slim in overall construction, with even lower transmission loss in the wiring.

【Brief Description of the Drawings】

【FIG. 1】

An axial sectional view showing a preferred embodiment of a generator with diverse power-generation characteristics in accordance with the present

invention.

【FIG. 2】

A cross-sectioned view taken along the plane A-A of FIG. 1 to illustrate concentrated-field windings or shunt-field windings on a stator core.

【FIG. 3】

A plan view showing a stator core.

【FIG. 4】

A schematic illustration explanatory of windings mounted on the stator core.

【FIG. 5】

A wiring diagram explaining circuit connections of the windings in the generator of FIG. 1.

【FIG. 6】

A graphic representation showing relations between rpm and output voltage occurring in the circuit connections in FIG. 5.

【FIG. 7】

A graphic representation showing three-phase currents created in the generator of the present invention.

【FIG. 8】

An illustration explanatory of star-connected winding sets.

【FIG. 9】

An illustration explanatory of delta-connected winding sets.

【Explanation of Reference Numerals】

1A, 1B flame halves
2 rotor shaft
3 permanent-magnet piece
4 reinforcing member
5 rotor
6 stator
7 stator core
8 magnetic path
9 slot
10 stator teeth
11 resinous mateiral
12 permeable member
13A, 13B, 13C winding
14 terminal
15 permanent-magnet piece
20 slot opening
22 air gap
30 controller unit
33, 34, 35, 36, 37, 38 switch
33A, 33B, 35A, 35B switch
39 bridge circuit
42 voltage regulator